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User's Guide

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Miniature Two-Wire Thermocouple Transmitter

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1 Introduction

1.1 General Description

The OMEGA® TX90 Series Temperature Transmitters consist of the TX91 Miniature Two-Wire Thermocouple Transmitter and the TX92 Miniature Two-Wire RTD Transmitter. This manual is written for the OMEGA TX91 Thermocouple Transmitter.

The TX91 Transmitter accepts thermocouple sensor types J, K, T, or E and will produce a standard 4-20 mA output signal proportional to that produced by its attached input temperature sensor. Transmission of the proportional current output may be accomplished by using copper wires.

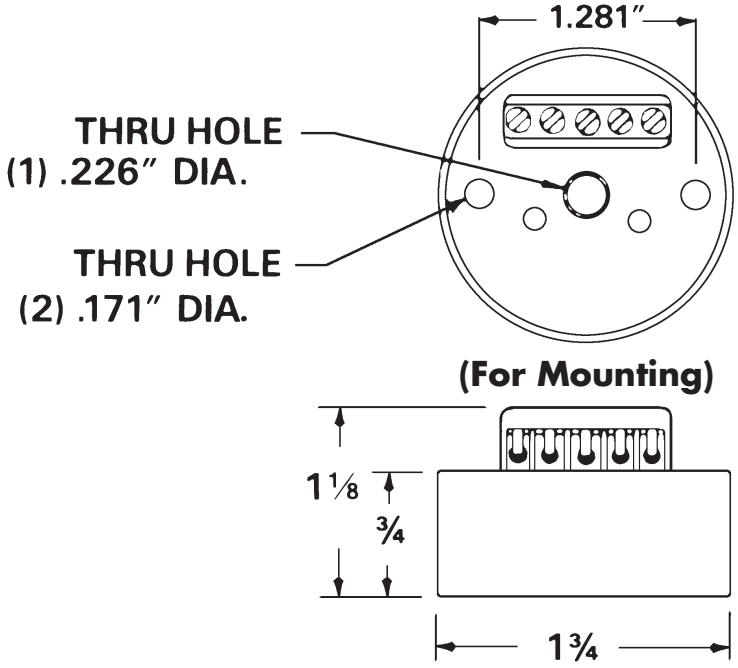


Figure 1-1. Photo of TX90 Series Transmitter
Figure 1-2. General Dimensions (in inches)

The TX91 transmitter is normally powered by an unregulated DC power supply as shown in Figure 1-3. The proportionally-transmitted signal begins at 4 mA, at the low end of its temperature range, and increases to 20 mA, at the high end of its temperature range. (There are various temperature ranges and thermocouple types available for the TX91. To order, refer to Section 1.3 for correct Model Numbers and Range Codes.)

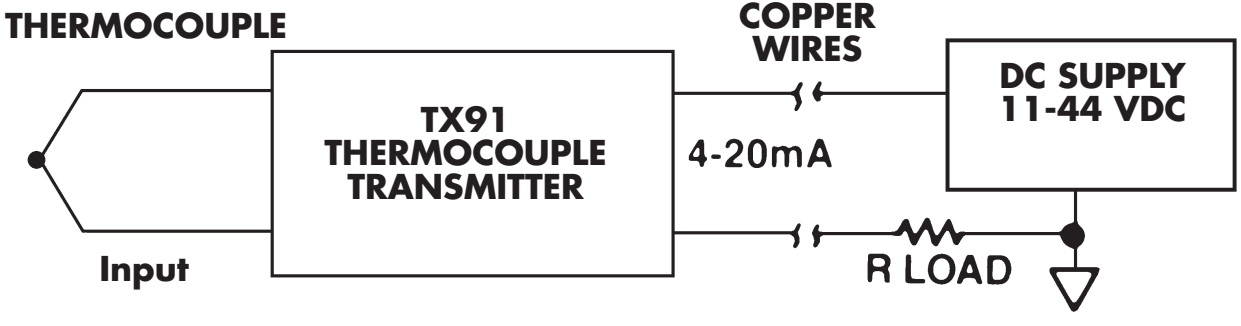


Figure 1-3. TX91 Thermocouple Transmitter

The TX91 two-wire transmitter receives and measures signals from thermocouples and sends an output current of 4-20 mA which is directly proportional to the thermocouple millivolt input. It is designed to connect with only two copper wire leads that will supply the voltage to operate the transmitter from a DC power supply, and also carry the output current. The output current is then used for recording, computing or controlling.

If the TX91 is mounted inside a protection head, such as the OMEGA NB1 Protection Head (see Figure 3-1), the thermocouple extension wires are replaced by two copper wires that carry the 4-20 mA signal and DC voltage to operate the transmitter. (Refer to the OMEGA Temperature Handbook for information on NB1 Thermocouple Assembly.)

The TX91 has reverse supply polarity protection and will operate with a wide range of supply voltages (11 to 44VDC). It has an input sensor break-protection circuit that forces the output current to go upscale when the thermocouple wire opens. It also is provided with a screw terminal, where the output current can be measured without interrupting the power loop. The TX91 does NOT provide isolation between its input and the 4-20 mA output; therefore, an undergrounded thermocouple junction is suggested to prevent possible ground loops.

Note that most thermocouple transmitters with 4-20 mA outputs, including the TX91, are proportional with respect to the thermocouple input voltage. However, the relationship between temperature and millivolt for all the thermocouple types is somewhat non-linear. This leads to maximum error at approximately the midpoint of the range as shown in Figure 1-4.

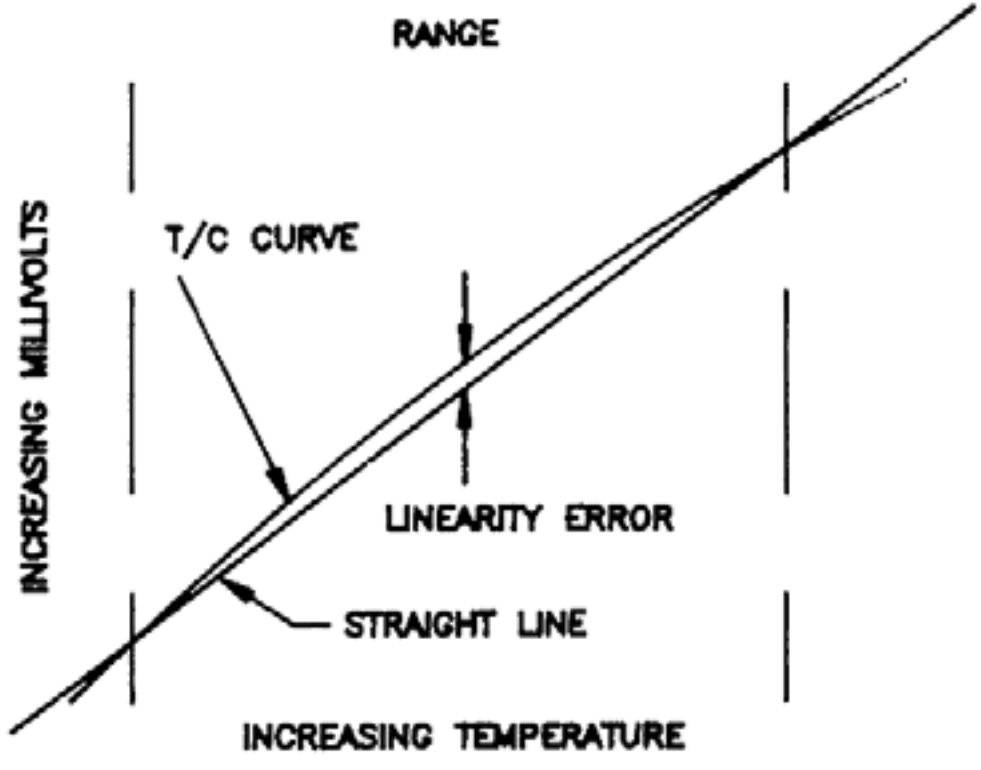


Figure 1-4. Straight line Approximation of Curve

1.2 Features

- 4-20 mA output
- ±0.1% full-scale accuracy (with respect to the mV input signal)
- Upscale break protection
- Low cost

1.3 Models Available

Table 1-1. Range Code

Range	Input Types J	K	T	E
0 to 200°F	J2	K2	T2	E2
0 to 300°F	J3	K3	T3	E3
0 to 500°F	J4	K4	T4	E4
0 to 750°F	J5	K5		E5
0 to 1000°F	J6	K6		E6

TX91 Models Available	
Model Number	**Description**
TX91-(*)	Thermocouple transmitter (J, K, T, or E)
NB1TX-(*)	NB1 thermocouple probe, 12" L, 1/4" O.D., ungrounded junction, 304SS sheath, TX91Transmitter

**Insert range code from Table 1-1*

For complete information on NB1 Thermocouple Probes, see the OMEGA Temperature Handbook.

2 Unpacking

Remove the packing list and verify that all equipment has been received. If there are any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

Upon receipt of shipment, inspect the container and equipment for signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material in event reshipment is necessary.

3 Installation

3.1 Mounting the TX91

The TX91 Transmitter may be:

1. surface mounted,
2. mounted inside a protection head (refer to figure 3-1), or
3. installed into the OMEGA mounting track (part number RT) using an OMEGA mounting bracket (part number TX90-BR).

Figure 3-2 shows the RT mounting track.
Figure 3-3 shows the TX90-BR mounting bracket.
Figure 3-4 shows a typical installation of two transmitters using the mounting bracket and mounting track.

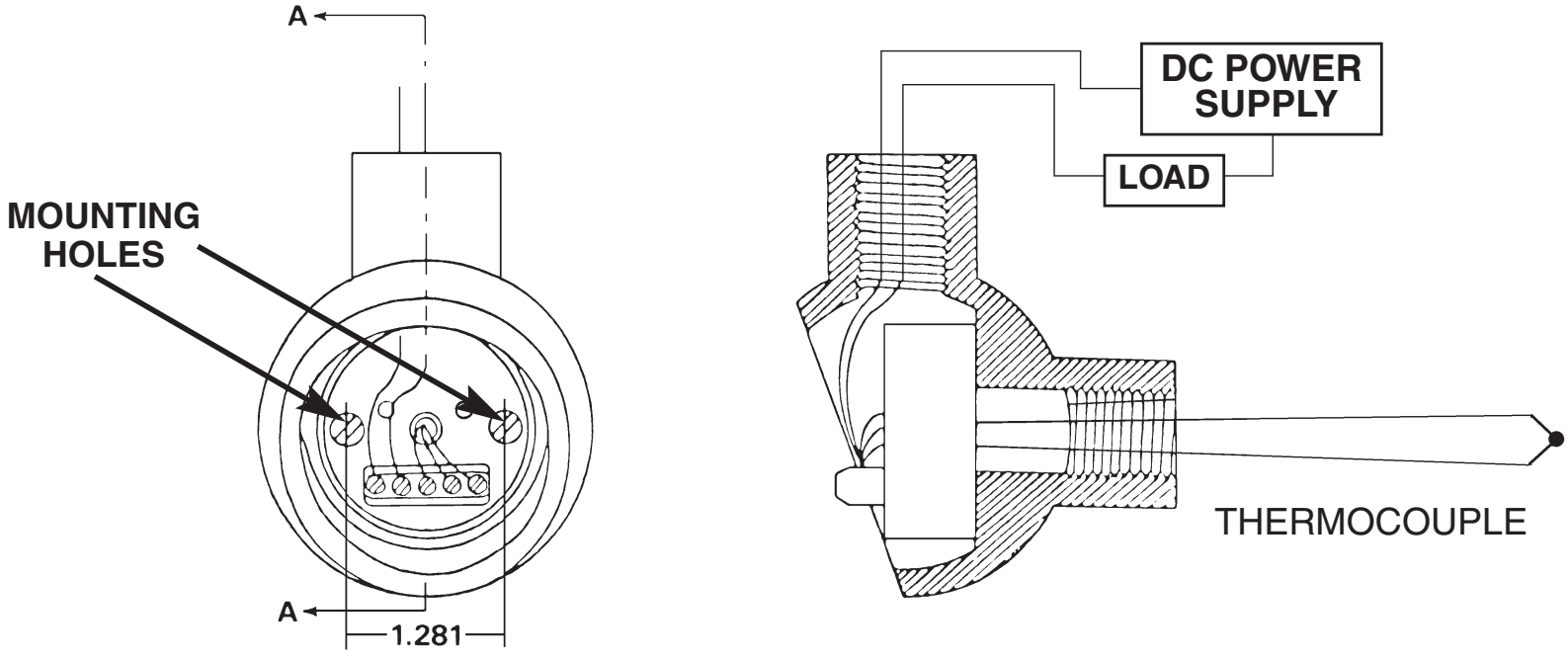
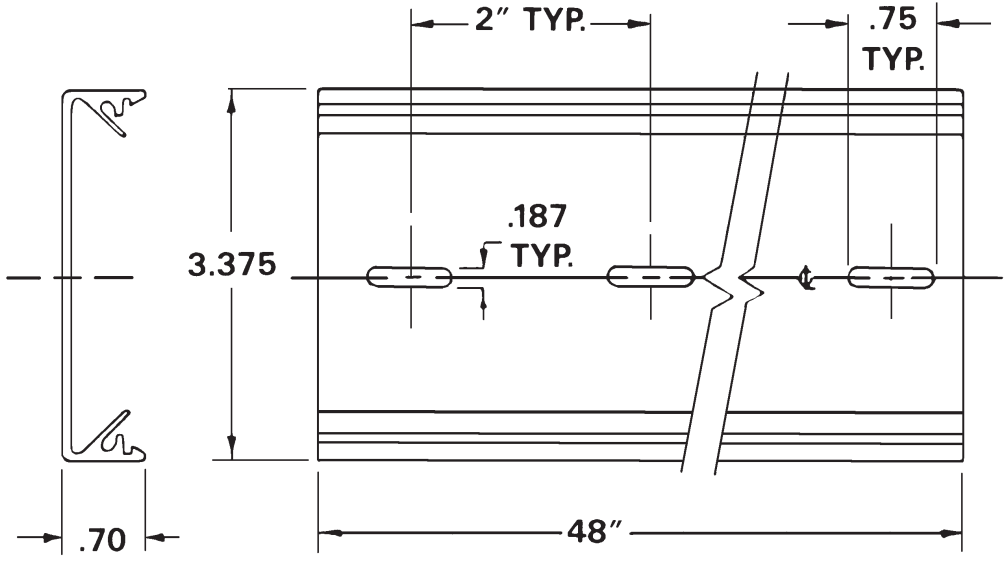


Figure 3-1 Assembly of the TX91 Transmitter Inside an OMEGA NB1 Protection Head (in inches)



CAUTION

HANDTIGHTEN TRANSMITTER MOUNTING SCREWS ONLY. DO NOT OVER-TIGHTEN.

Figure 3-2 RT Mounting Track (in inches)

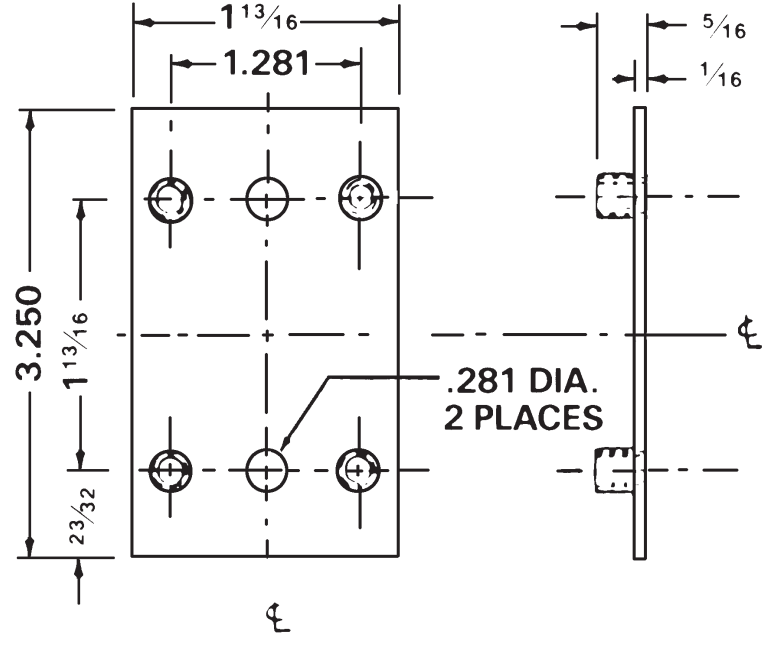


Figure 3-3 TX90-BR Mounting Bracket (in inches)

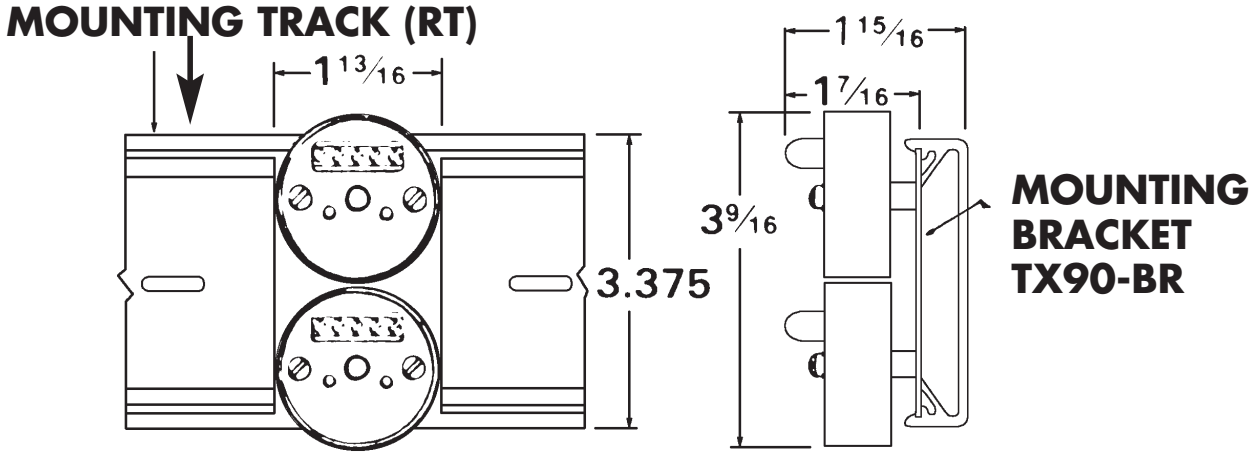


Figure 3-4 Installation with Bracket and Track (in inches) TX90-BR & RT

3.2 Wiring the TX91 (Refer to Figure 3-5)

1. Connect a DC power supply in series with the load to the (+PS) and (-PS) power terminals. Note that the load (usually a monitoring instrument) may be connected to either the (+) or (-) power lead.
2. Connect the thermocouple to the (+IN) and (-IN) input terminals.

NOTE

A milliamp monitoring instrument can be used in the circuit by connecting the monitor's positive lead to (+PS) and the negative lead to (M). This allows monitoring the current loop without disconnecting the main wiring.

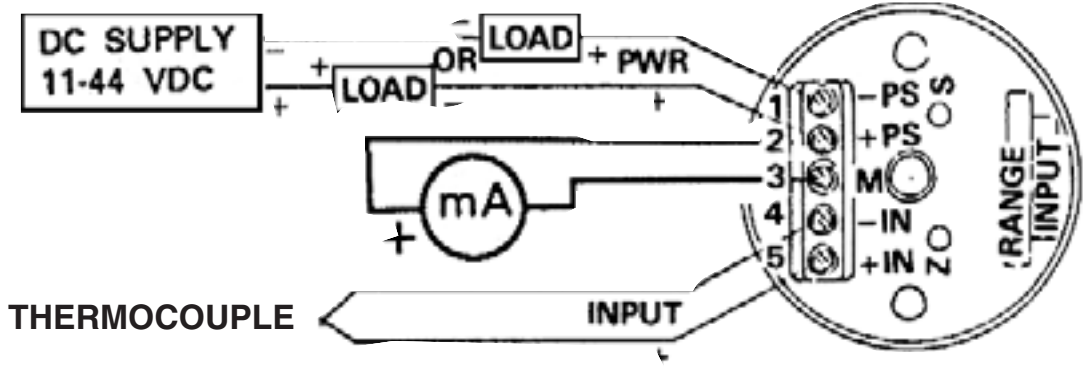


Figure 3-5 Wiring Diagram for the TX91 Potentiometers

4 Calibration Instructions

4.1 Equipment Required

1. • Precision mV source, with 0.001 mV resolution and ±0.002mV accuracy or
   • Precision DVM with ±0.002mV accuracy and adjustable mV source with 0.001mV resolution
   • OMEGA TRC III Ice Point Reference (or stable ice bath)
2. • Temperature Reference Probe (OMEGA P/N: TRP-(*))
   **Thermocouple Type: J, K, T, E*
   • Or a Thermocouple Calibrator/Simulator

4.2 Set-up of Equipment

To prepare the ice bath:

a) Fill a glass beaker with crushed ice made from distilled water.

b) Fill the beaker with enough distilled water so that ice just becomes slush, but not enough to float the ice.

c) Insert the reference thermocouple.

Figure 4-2 shows an alternate set-up. Here, a high precision thermocouple calibrator, such the OMEGA Model CL511, replaces the DVM, ice bath, voltage source, etc.

4.3 Calibration Procedures (Refer to Figure 4-1)

Connect the calibration equipment according to Figure 4-1 or 4-2. The thermocouple wire (J, K, T, E) must be of the same calibration as the transmitter being calibrated. Make sure that the wiring polarities are correct. (Note that the RED thermocouple wire is NEGATIVE.)

To check or adjust the calibration:

1. Locate the Z (zero) and S (span) potentiometers.
2. Select, from Table 4-1, the correct mV values for the Z (zero) and S (span) adjustments that correspond to the Model Number. For example, for Model TX91-J2, the Z input is -0.885 mV, and the S input is 4.906 mV.

If a Thermocouple Calibrator/Simulator is used, such as the OMEGA Model CL511 Precision Calibrator, select the Temperature Input Z (zero) and S (span) values.

3. Set the DC mV source to the selected Z (zero) mV value. Adjust the Z potentiometer to read 4.000 mA on the monitoring instrument.
4. Set the DC mV source to the selected S (span) mV value. Adjust the S potentiometer to read 20.000 mA on the monitoring instrument.
5. Repeat steps 3 and 4, as required, until the readings are exactly 4.000 mA and 20.000 mA. This procedure is necessary since there is interaction between the two potentiometers.

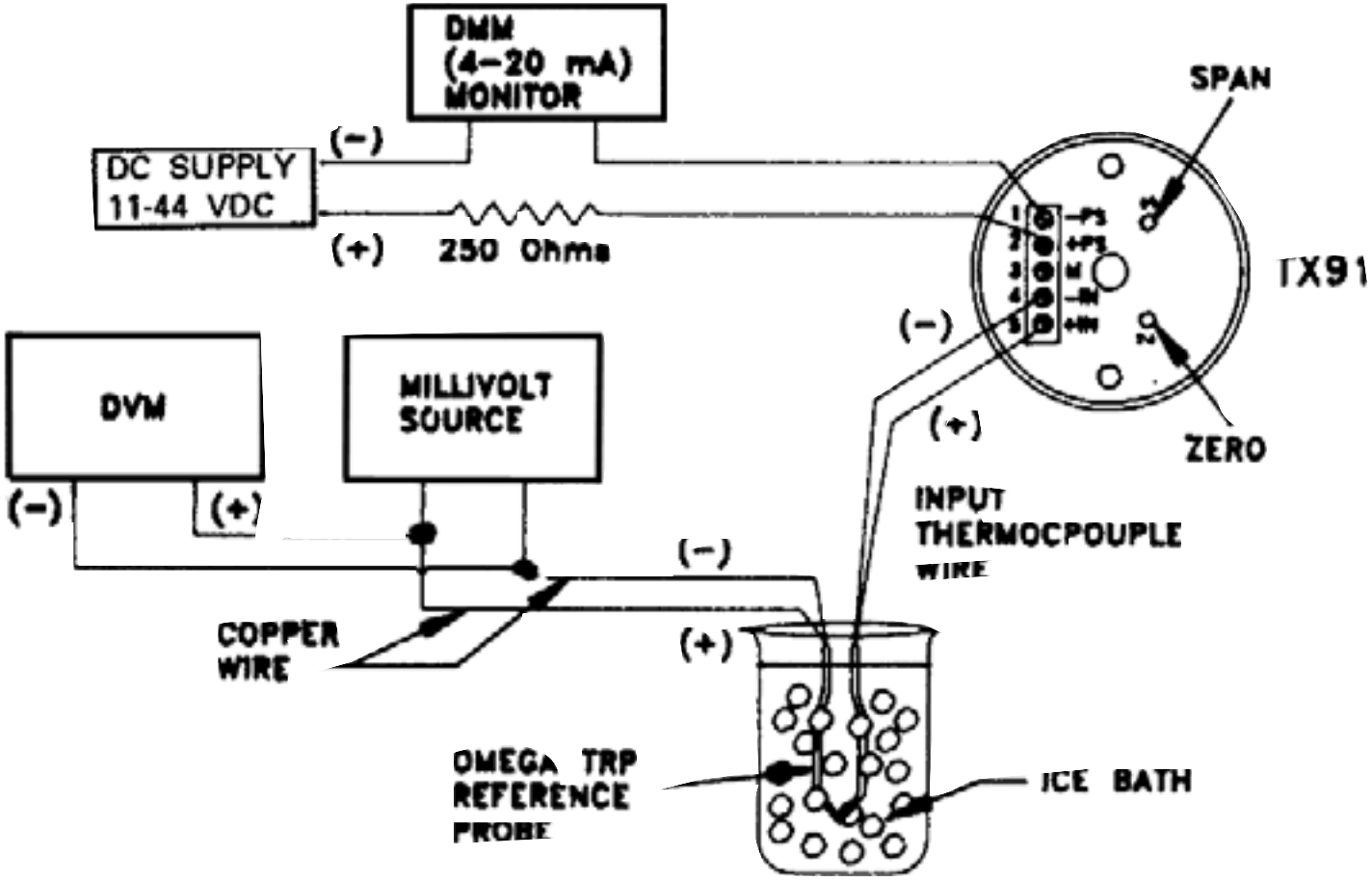


Figure 4-1. Calibration Set-Up

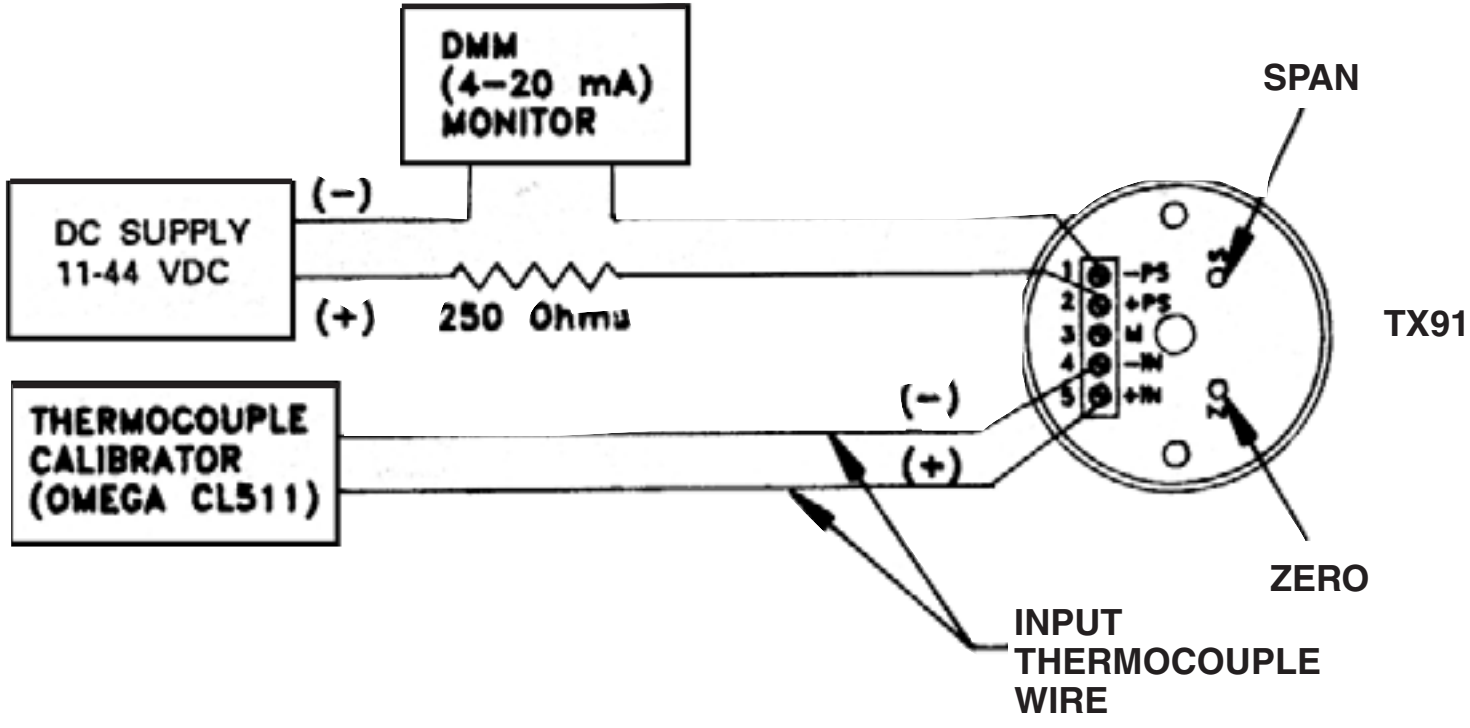


Figure 4-2. Calibration Set-Up. (Alternate)

Table 4-1. Calibration Values for the TX92

Temperature Input Range Zero/Span	Model TX92	mV INPUT REF 32°F Zero/Span	Model TX92	mV INPUT REF 32°F Zero/Span
0/ 200°F	-J2	-0.855/ 4.906	-K2	-0.692/ 3.819
0/ 300°F	-J3	-0.885/ 7.947	-K3	-0.692/ 6.092
0/ 500°F	-J4	-0.885/14.108	-K4	-0.692/10.560
0/ 750°F	-J5	-0.885/20.406	-K5	-0.692/15.295
0/1000°F	-J6	-0.885/29.515	-K6	-0.692/22.251
0/ 200°F	-T2	-0.674/ 3.967	-E2	-1.026/ 5.869
0/ 300°F	-T3	-0.674/ 6.647	-E3	-1.026/ 9.708
0/ 500°F	-T4	-0.674/12.572	-E4	-1.026/17.942
0/ 750°F	--	--	-E5	-1.026/26.858
0/1000°F	--	--	-E6	-1.026/40.056

5 Troubleshooting Guide

Malfunction or incorrect operation may be caused by:

1. Reversed polarity:
   Check the wiring using Figure 3-5 as a guide. If the temperature of the thermocouple increases while the current magnitude decreases, the problem could caused by reversed polarity of the:
   a) thermocouple wiring
   b) power supply leads
   c) monitor instrument
2. Loose or broken wires:
   Check each terminal connection for tightness. Move each wire back and forth and note any changes in operation.
3. Too high a load resistance in the output current loop or too low a current rating on the power supply:

a) Measure the total resistance of each device (excluding the transmitter and power supply) in the 20 mA loop, including the resistance of the lead wires.

b) Calculate the maximum allowable loop resistance using the formula:

$$\text{Loop Resistance (maximum)} = \frac{V_{supply} - 11V}{0.020A}$$

For example, a 24V power supply would give a maximum loop resistance of: 13V/0.020A = 650 ohms.

c) Make sure the power supply is rated for at least 28 mA times the number of TX91 transmitters being powered. For example, if the supply is powering 5 transmitters, the supply should be rated for at least 140 mA.

6 Accessories

Model No.	Description
TX90-BR	Mounting Bracket
PSU-24B	Unregulated Power Supply, 24 Volts
TX82A	Process Loop-Powered Indicator
RT	48″ Mounting Track

7 Specifications

General

SIZE:	1.75" dia. X 1.125" high (includes terminal strip)
ZERO/SPAN ADJUSTMENT RANGE:	±25%
POWER SUPPLY VOLTAGE OPERATING RANGE:	+11VDC to +44VDC, 28 mA max required per transmitter
ACCURACY:	±0.1% of full scale (includes effects of hysteresis, repeatability and linearity proportional to the T/C)
AMBIENT TEMPERATURE:	-13°F to 185°F (-25°C to 85°C)
STORAGE TEMPERATURE RANGE:	-85°F to 193°F (-65°C to 89°C)

THERMAL ZERO SHIFT:	<0.01%/°F of span (span >5 mV) <0.02%/°F of span (2-5 mV span)
THERMAL SPAN SHIFT:	<0.01%/°F of span
WEIGHT:	1.5 oz (50g)

Output

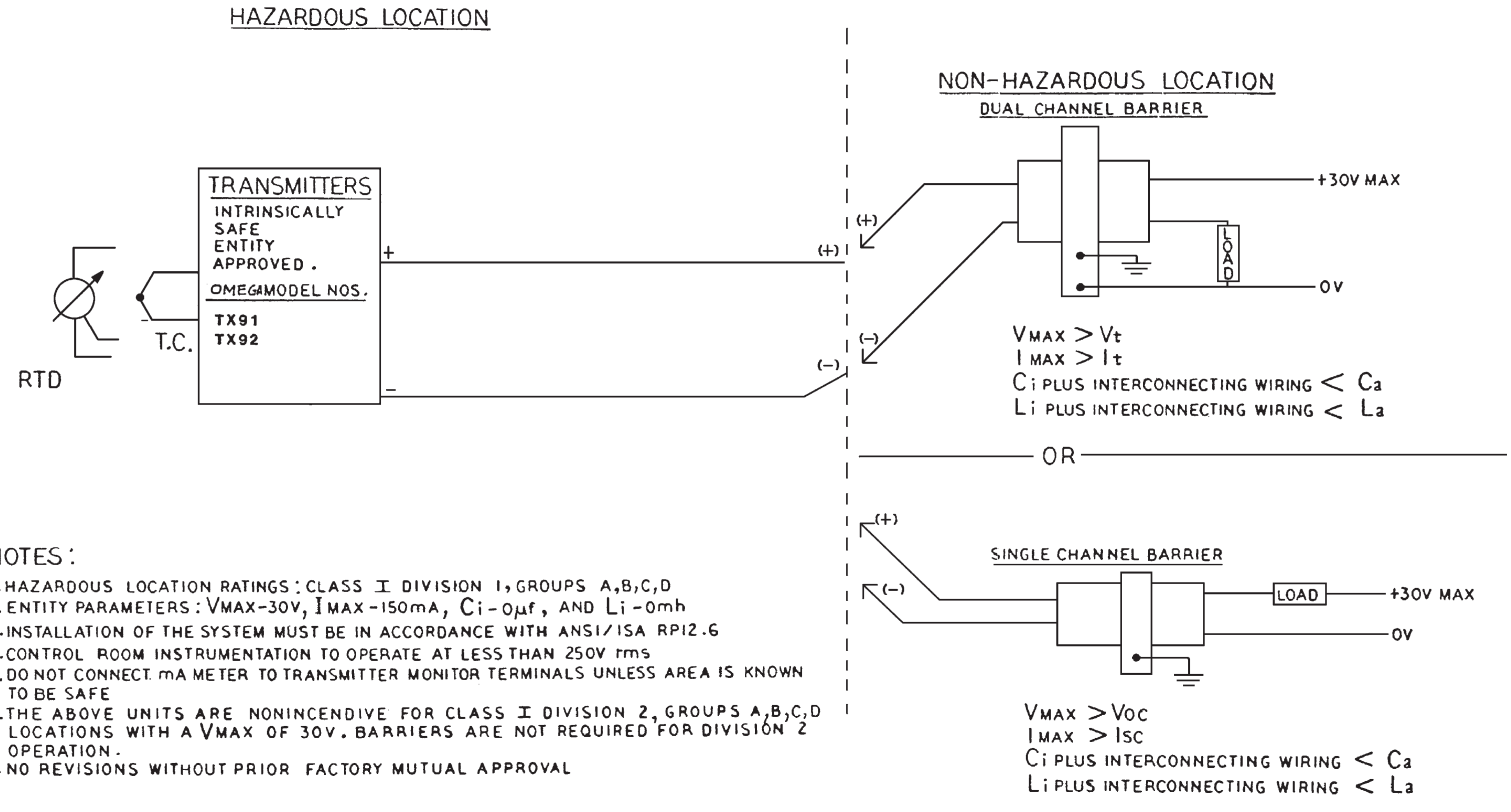
CURRENT OUTPUT SPAN:	4-20 mA DC
CURRENT OUTPUT LIMITS:	3 to 28 mA, typical
MAXIMUM LOOP RESISTANCE:	$(V_{supply} - 11V)/0.020A$ = ohms
LOAD RESISTANCE EFFECT:	0.05% of span per 300 ohms change
POWER SUPPLY EFFECT:	0.01% of output span per volt

Input

SENSOR:	Thermocouple
IMPUT BREAK PROTECTION:	Upscale
IMPEDANCE:	200K Ω

Appendix A

Intrinsically Safe Interconnection Diagram



NOTES:

1. HAZARDOUS LOCATION RATINGS: CLASS I DIVISION 1, GROUPS A,B,C,D
2. ENTITY PARAMETERS: VMAX-30V, IMAX-150mA, Ci-0μf, AND Li-0mh
3. INSTALLATION OF THE SYSTEM MUST BE IN ACCORDANCE WITH ANSI/ISA RP12.6
4. CONTROL ROOM INSTRUMENTATION TO OPERATE AT LESS THAN 250V rms
5. DO NOT CONNECT mA METER TO TRANSMITTER MONITOR TERMINALS UNLESS AREA IS KNOWN TO BE SAFE
6. THE ABOVE UNITS ARE NONINCENDIVE FOR CLASS I DIVISION 2, GROUPS A,B,C,D LOCATIONS WITH A VMAX OF 30V. BARRIERS ARE NOT REQUIRED FOR DIVISION 2 OPERATION.
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